WHAT IS CLAIMED IS:

1. A plasma processing method for generating plasma within a vacuum chamber and processing a substrate placed on a substrate electrode within the vacuum chamber, the method comprising:

generating the plasma by supplying a high-frequency power having a frequency of 50 MHz to 3 GHz to a counter electrode provided opposite to the substrate while interior of the vacuum chamber is controlled to a specified pressure by introducing gas into the vacuum chamber and, simultaneously therewith, evacuating the interior of the vacuum chamber; and

processing the substrate by using the generated plasma while plasma distribution of the plasma on the substrate is controlled by an annular, groove-like plasma trap provided opposite to the substrate.

2. A plasma processing method for generating plasma within a vacuum chamber and processing a substrate placed on a substrate electrode within the vacuum chamber, the method comprising:

generating the plasma by radiating electromagnetic waves into the vacuum chamber via a dielectric window provided opposite to the substrate by supplying a high-frequency power having a frequency of 50 MHz to 3 GHz to an antenna while interior of the vacuum chamber is controlled

to a specified pressure by introducing gas into the vacuum chamber and, simultaneously therewith, evacuating the interior of the vacuum chamber; and

processing the substrate by using the generated plasma while plasma distribution of the plasma on the substrate is controlled by an annular, groove-like plasma trap provided opposite to the substrate.

3. A plasma processing method according to Claim 1, wherein the substrate is processed while a portion surrounded by the plasma trap out of a surface forming an inner wall surface of the vacuum chamber and opposing the substrate has an area 0.5 to 2.5 times that of the substrate.

4. A plasma processing method according to Claim 1, wherein the substrate is processed while the plasma trap has a groove width of 3 mm to 50 mm.

5. A plasma processing method according to Claim 1, wherein the substrate is processed while the plasma has a groove depth of not less than 5 mm.

6. A plasma processing method according to Claim 1, wherein the substrate is processed while the plasma trap is provided in the counter electrode.

7. A plasma processing method according to Claim 1, wherein the plasma is generated while the plasma trap is provided outside an insulating ring for insulating the vacuum chamber and the counter electrode from each other.

8. A plasma processing method according to Claim 1, wherein the plasma is generated while the plasma trap is provided between the counter electrode and an insulating ring for insulating the vacuum chamber and the counter electrode from each other.

9. A plasma processing method according to Claim 1, wherein the plasma is generated while the plasma trap is provided between the vacuum chamber and an insulating ring for insulating the vacuum chamber and the counter electrode from each other.

10. A plasma processing method according to Claim 2, wherein the plasma is generated while the plasma trap is provided in the dielectric window.

11. A plasma processing method according to Claim 2, wherein the plasma is generated while the plasma trap is provided outside the dielectric window.

12. A plasma processing method according to Claim 2, wherein the plasma is generated while the plasma trap is provided between the vacuum chamber and the dielectric window.

13. A plasma processing method according to Claim 1, wherein the plasma is generated while DC magnetic fields are absent within the vacuum chamber.

14. A plasma processing apparatus comprising:

a vacuum chamber;

a gas supply unit for supplying gas into the vacuum chamber;

an evacuating device for evacuating interior of the vacuum chamber;

a substrate electrode for placing thereon a substrate within the vacuum chamber;

a counter electrode provided opposite to the substrate electrode;

high-frequency power supply capable of supplying a high-frequency power having a frequency of 50 MHz to 3 GHz to the counter electrode; and

an annular, groove-like plasma trap provided opposite to the substrate.

A plasma processing apparatus comprising:

a vacuum chamber;

a gas supply unit for supplying gas into the vacuum chamber;

an evacuating device for evacuating interior of the vacuum chamber;

a substrate electrode for placing thereon a substrate within the vacuum chamber;

a dielectric window provided opposite to the substrate electrode;

an antenna for radiating electromagnetic waves into the vacuum chamber via the dielectric window;

high-frequency power supply capable of supplying a high-frequency power having a frequency of 50 MHz to 3 GHz to the antenna; and

an annular, groove-like plasma trap provided opposite to the substrate.

16. A plasma processing apparatus according to Claim 14, wherein a portion surrounded by the plasma trap out of a surface forming an inner wall surface of the vacuum chamber and opposing the substrate has an area 0.5 to 2.5 times that of the substrate.

17. A plasma processing apparatus according to Claim 14, wherein the plasma trap has a groove width of 3 mm to 50 mm.

18. A plasma processing apparatus according to Claim 14 ~~or 15~~, wherein the plasma has a groove depth of not less than 5 mm.

19. A plasma processing apparatus according to Claim 14, wherein the plasma trap is provided in the counter electrode.

20. A plasma processing apparatus according to Claim 14, wherein the plasma trap is provided in an insulating ring for insulating the vacuum chamber and the counter electrode from each other.

21. A plasma processing apparatus according to Claim 14, wherein the plasma trap is provided outside an

insulating ring for insulating the vacuum chamber and the counter electrode from each other.

22. A plasma processing apparatus according to Claim 14, wherein the plasma trap is provided between the counter electrode and an insulating ring for insulating the vacuum chamber and the counter electrode from each other.

23. A plasma processing apparatus according to Claim 14, wherein the plasma trap is provided between the vacuum chamber and an insulating ring for insulating the vacuum chamber and the counter electrode from each other.

24. A plasma processing apparatus according to Claim 15, wherein the plasma trap is provided in the dielectric window.

25. A plasma processing apparatus according to Claim 15, wherein the plasma trap is provided outside the dielectric window.

26. A plasma processing apparatus according to Claim 15, wherein the plasma trap is provided between the vacuum chamber and the dielectric window.

27. A plasma processing apparatus according to Claim 14, wherein no coil or permanent magnet for applying DC magnetic fields is provided within the vacuum chamber.

28. A plasma processing apparatus according to Claim 1, further comprising a matching box for use in the plasma processing apparatus and for taking impedance matching in

supplying high-frequency power to a load, the matching box comprising:

a high-frequency input terminal;

a first reactive element having one end connected to the high-frequency input terminal and the other end connected to a matching box casing;

a high-frequency output terminal; and

a second reactive element having one end connected to the high-frequency input terminal and the other end connected to the high-frequency output terminal,

wherein the second reactive element and the high-frequency output terminal are so arranged that the second reactive element is located on a straight line passing through a center axis of the high-frequency output terminal.

29. A plasma processing apparatus according to Claim 28, wherein the first reactive element and the second reactive element are capacitors, respectively.

30. A matching box for use in a plasma processing apparatus and for taking impedance matching in supplying high-frequency power to a load, the matching box comprising:

a high-frequency input terminal;

a first reactive element having one end connected to the high-frequency input terminal and the other end connected to a matching box casing;

a high-frequency output terminal; and

a second reactive element having one end connected to the high-frequency input terminal and the other end connected to the high-frequency output terminal,

wherein the second reactive element and the high-frequency output terminal are so arranged that the second reactive element is located on a straight line passing through a center axis of the high-frequency output terminal.

31. A matching box for a plasma processing apparatus according to Claim 30, wherein the second reactive element and the high-frequency output terminal are so arranged that a straight line passing through a center axis of the second reactive element and a straight line passing through the center axis of the high-frequency output terminal are generally coincident with each other.

32. A matching box for a plasma processing apparatus according to Claim 30, wherein the first reactive element and the second reactive element are capacitors, respectively.

33. A matching box for a plasma processing apparatus according to Claim 30, wherein the first reactive element and the second reactive element are so arranged that a straight line passing through a center axis of the second reactive element and a straight line passing through a center axis of the first reactive element are generally

coincident with each other.

34. A matching box for a plasma processing apparatus according to Claim 30, wherein the high-frequency output terminal is the other end itself of the second reactive element.

35. A plasma processing method for generating plasma within a vacuum chamber and processing a substrate placed on a substrate electrode within the vacuum chamber, the method comprising:

so arranging a straight line passing through a center axis of the high-frequency coupling device, a straight line passing through a center axis of the counter electrode or antenna, and a straight line passing through a center axis of the substrate as to be generally coincident together;

controlling interior of the vacuum chamber to a specified pressure by introducing a gas into the vacuum chamber and, simultaneously therewith, exhausting the interior of the vacuum chamber;

generating the plasma by applying a high-frequency power having a frequency of 50 MHz to 300 MHz to a counter electrode or antenna provided opposite to the substrate via the matching box as defined in Claim 30 and a high-frequency coupling device provided to connect a high-frequency output terminal of the matching box and the

counter electrode or antenna to each other: and

processing the substrate by using the generated plasma.

36. A plasma processing method according to Claim 35, further comprising: before controlling the interior of the vacuum chamber to the specified pressure,

so arranging a straight line passing through a center axis of the high-frequency output terminal and a straight line passing through the center axis of the high-frequency coupling device as to be generally coincident with each other,

wherein the plasma is generated with the straight line passing through the center axis of the high-frequency output terminal and the straight line passing through the center axis of the high-frequency coupling device being generally coincident with each other.

37. A plasma processing method according to Claim 35, further comprising: before controlling the interior of the vacuum chamber to the specified pressure,

so arranging the first reactive element and the second reactive element that a straight line passing through a center axis of the second reactive element and a straight line passing through a center axis of the first reactive element are generally coincident with each other,

wherein the plasma is generated with the straight

line passing through the center axis of the second reactive element and the straight line passing through the center axis of the first reactive element being generally coincident with each other.

38. A plasma processing method according to Claim 35, comprising: before controlling the interior of the vacuum chamber to the specified pressure,

arranging the high-frequency output terminal so as to be the other end itself of the second reactive element,

wherein the plasma is generated with the high-frequency output terminal being the other end itself of the second reactive element.

39. A plasma processing method according to Claim 35, comprising: before controlling the interior of the vacuum chamber to the specified pressure,

arranging substantial distance from the other end of the second reactive element to the counter electrode or antenna to be not more than 1/10 of wavelength of the high-frequency power,

wherein the plasma is generated with the substantial distance from the other end of the second reactive element to the counter electrode or antenna being not more than 1/10 of wavelength of the high-frequency power.

40. A plasma processing method for generating plasma within a vacuum chamber and processing a substrate placed on a substrate electrode within the vacuum chamber, the method comprising:

so arranging a straight line passing through a center axis of the high-frequency coupling device, a straight line passing through a center axis of the counter electrode or antenna, and a straight line passing through a center axis of the substrate as to be generally coincident together;

controlling interior of the vacuum chamber to a specified pressure by introducing a gas into the vacuum chamber and, simultaneously therewith, exhausting the interior of the vacuum chamber;

generating the plasma by applying a high-frequency power having a frequency of 50 MHz to 300 MHz to a counter electrode or antenna provided opposite to the substrate via the matching box as defined in Claim 30 and a high-frequency coupling device provided to connect a high-frequency output terminal of the matching box and the counter electrode or antenna to each other; and

processing the substrate by using the generated plasma.

41. A plasma processing method according to Claim 40, further comprising: before controlling the interior of the

vacuum chamber to the specified pressure,

so arranging a straight line passing through a center axis of the high-frequency output terminal and a straight line passing through the center axis of the high-frequency coupling device as to be generally coincident with each other,

wherein the plasma is generated with the straight line passing through the center axis of the high-frequency output terminal and the straight line passing through the center axis of the high-frequency coupling device being generally coincident with each other.

42. A plasma processing method according to Claim 40, further comprising: before controlling the interior of the vacuum chamber to the specified pressure,

so arranging the first variable capacitor and the second variable capacitor that a straight line passing through a center axis of the second variable capacitor and a straight line passing through a center axis of the first variable capacitor are generally coincident with each other,

wherein the plasma is generated with the straight line passing through the center axis of the second variable capacitor and the straight line passing through the center axis of the first variable capacitor being generally coincident with each other.

43. A plasma processing method according to Claim 40,

comprising: before controlling the interior of the vacuum chamber to the specified pressure,

arranging the high-frequency output terminal so as to be the other end itself of the second reactive element,

wherein the plasma is generated with the high-frequency output terminal being the other end itself of the second variable capacitor.

44. A plasma processing method according to Claim 40, further comprising: before controlling the interior of the vacuum chamber to the specified pressure,

arranging substantial distance from the other end of the second variable capacitor to the counter electrode or antenna to be not more than 1/10 of wavelength of the high-frequency power,

wherein the plasma is generated with the substantial distance from the other end of the second variable capacitor to the counter electrode or antenna to be not more than 1/10 of wavelength of the high-frequency power.

45. A plasma processing apparatus comprising:

a vacuum chamber;

a gas supply unit for supplying gas into the vacuum chamber;

an evacuating device for evacuating interior of

the vacuum chamber;

a substrate electrode for placing thereon a substrate within the vacuum chamber;

a counter electrode or an antenna provided opposite to the substrate electrode;

high-frequency power supply capable of supplying a high-frequency power having a frequency of 50 MHz to 300 MHz to the counter electrode or antenna;

the matching box as defined in Claim 30; and

a high-frequency coupling device for connecting the high-frequency output terminal of the matching box and the counter electrode or antenna to each other,

wherein a straight line passing through a center axis of the high-frequency coupling device, a straight line passing through a center axis of the counter electrode or antenna, and a straight line passing through a center axis of the substrate are so arranged as to be generally coincident together.

46. A plasma processing apparatus according to Claim 45, wherein a straight line passing through a center axis of the high-frequency output terminal and a straight line passing through the center axis of the high-frequency coupling device are so arranged as to be generally coincident with each other.

47. A plasma processing apparatus according to Claim

45, wherein the first reactive element and the second reactive element are so arranged that a straight line passing through a center axis of the second reactive element and a straight line passing through a center axis of the first reactive element are generally coincident with each other.

48. A plasma processing apparatus according to Claim 45, wherein the high-frequency output terminal is the other end itself of the second reactive element.

49. A plasma processing apparatus according to Claim 45, wherein substantial distance from the other end of the second reactive element to the counter electrode or antenna is not more than 1/10 of wavelength of the high-frequency power.

50. A plasma processing apparatus comprising:

a vacuum chamber;

a gas supply unit for supplying gas into the vacuum chamber;

an evacuating device for evacuating interior of the vacuum chamber;

a substrate electrode for placing thereon a substrate within the vacuum chamber;

a counter electrode or an antenna provided opposite to the substrate electrode;

high-frequency power supply capable of supplying

a high-frequency power having a frequency of 50 MHz to 300 MHz to the counter electrode or antenna;

~~the matching box as defined in Claim 30; and~~

a high-frequency coupling device for connecting the high-frequency output terminal of the matching box and the counter electrode or antenna to each other,

wherein a straight line passing through a center axis of the high-frequency coupling device, a straight line passing through a center axis of the counter electrode or antenna, and a straight line passing through a center axis of the substrate are so arranged as to be generally coincident together.

51. A plasma processing apparatus according to Claim 50, wherein the plasma is generated while the straight line passing through the center axis of the high-frequency output terminal and the straight line passing through the center axis of the high-frequency coupling device are so arranged as to be generally coincident with each other.

52. A plasma processing apparatus according to Claim 50, wherein a first variable capacitor and a second variable capacitor are so arranged that a straight line passing through a center axis of the second variable capacitor and a straight line passing through a center axis of the first variable capacitor are generally coincident with each other.

53. A plasma processing apparatus according to Claim

50, wherein the high-frequency output terminal is the other end itself of the second variable capacitor.

54. A plasma processing apparatus according to Claim 50, wherein substantial distance from the other end of the second variable capacitor to the counter electrode or antenna is not more than 1/10 of wavelength of the high-frequency power.

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